CHAPTER 5

MATHEMATICAL SCIENCE OFFERINGS, ENROLLMENTS, AND INSTRUCTIONAL PRACTICES IN TWO-YEAR COLLEGES

This chapter reports estimated national enrollments in two-year college (tyc) mathematical science courses for fall 1985. The data are compared and contrasted with results of previous CBMS surveys of 1966, 1970, 1975, and 1980 and with general enrollment trends in two-year colleges. For information on the sampling procedure used in this survey, see the Introduction and Appendix A.

HIGHLIGHTS
(1980-1985)

- Mathematical science enrollments remained almost unchanged, decreasing by 1%.

- Overall tyc enrollments decreased by 2%.
  * Part-time students continued to account for nearly two-thirds of all tyc students.
  * Nearly two-thirds of tyc associate degrees are now in occupational programs.

- Mathematical science faculty increased by 12%. Full-time and part-time sectors each increased by 12%.

- Courses showing increases were as follows:
  * Statistics increased by 29%.
  * Calculus increased by 13%.

  * Remedial course enrollments reached 482,000, increasing by 9% since 1980. They now account for 47% of all tyc mathematical science enrollments and two-thirds of all remedial enrollments in higher education.
  * Other precalculus increased by 4%.
  * Computing increased by 3%.

- Courses showing decreases were as follows:
  * Technical mathematics decreased by 56%.
  * Business mathematics decreased by 42%.
  * Mathematics for liberal arts decreased by 42%. Enrollments in this course are now below 1966 levels.

- Access to computers increased and the impact of computers and calculators on mathematics teaching increased.

- Mathematics labs continued to grow in popularity and now can be found in 82% of two-year colleges.

- Self-paced instruction decreased sharply in the period 1980-1985.

AN OVERVIEW OF TWO-YEAR COLLEGES: IS THE BOOM OVER?

During the 60's and 70's, no other sector of higher education grew as rapidly as did two-year colleges. In the 60's their enrollments tripled; in the 70's they doubled. But in the 80's two-year college enrollment growth stopped; the period 1980-1985 showed an actual decrease. In 1960 two-year colleges accounted for only one-sixth of all undergraduate enrollments in mathematics. Today, the figure is nearly one-third.

Explosive growth of such proportions was accompanied by changes in programs, student populations, and faculty populations. In the early 60's, most two-year colleges had a liberal arts orientation, serving as feeders for four-year colleges. By the mid-60's, program emphases had undergone considerable change. A host of new programs in occupational areas were introduced: data processing, dental hygiene, electronics, practical nursing, automotive mechanics, accounting, bricklaying, carpentry, and police and fire science, to name a few. Today, less than half of two-year college students are enrolled in college transfer programs. The growing majority of students are enrolled in occupational programs, and two-thirds of associate degrees are in occupational programs.

Most of the students of the 60's were 18- and 19-year old high school graduates, planning to transfer to four-year colleges. Most of them were single, white, male, and attending on a full-time basis. Today, two-thirds of students are over 21, one-third are married, some lack high school diplomas, one-fourth are minority students, and more than one-half are women. Nearly two-thirds of these students are attending on a part-time basis, and one-half start their studies after age 21. Many of these students require training in remedial mathematics (arithmetic, high school geometry, elementary and intermediate algebra, and general mathematics). The growth of remedial courses has been dramatic; today they account for nearly half of all two-year college mathematics

enrollments. By way of contrast, calculus enrollments now account for only 10% of enrollments, down from 12% fifteen years ago but up slightly since 1980.

Faculty populations have also changed since 1960. Then nearly two-thirds of full-time faculty had previously taught in high schools. Many of them entered two-year colleges expecting to move up to teach calculus-level courses. In a short time, they found themselves teaching courses in arithmetic. Since then, economic pressures have resulted in a sharp swing toward the use of part-time faculty. In the mid-60's, full-timers outnumbered part-timers by two to one; today, part-timers outnumber full-timers. Another aspect of the economic times is the phenomenon of overload teaching. At present, 43% of all full-time faculty in mathematics are teaching overloads, most for extra pay.

Self-paced instruction appeared in a variety of forms in the 60's and 70's: CAI, audio tutorial, television, modules, PSI, and film. With the current decrease in class sizes, we note a sharp decrease in their popularity.

Additional details on trends in course offerings, faculty populations, and changes in two-year college teaching environments are given in the following pages.

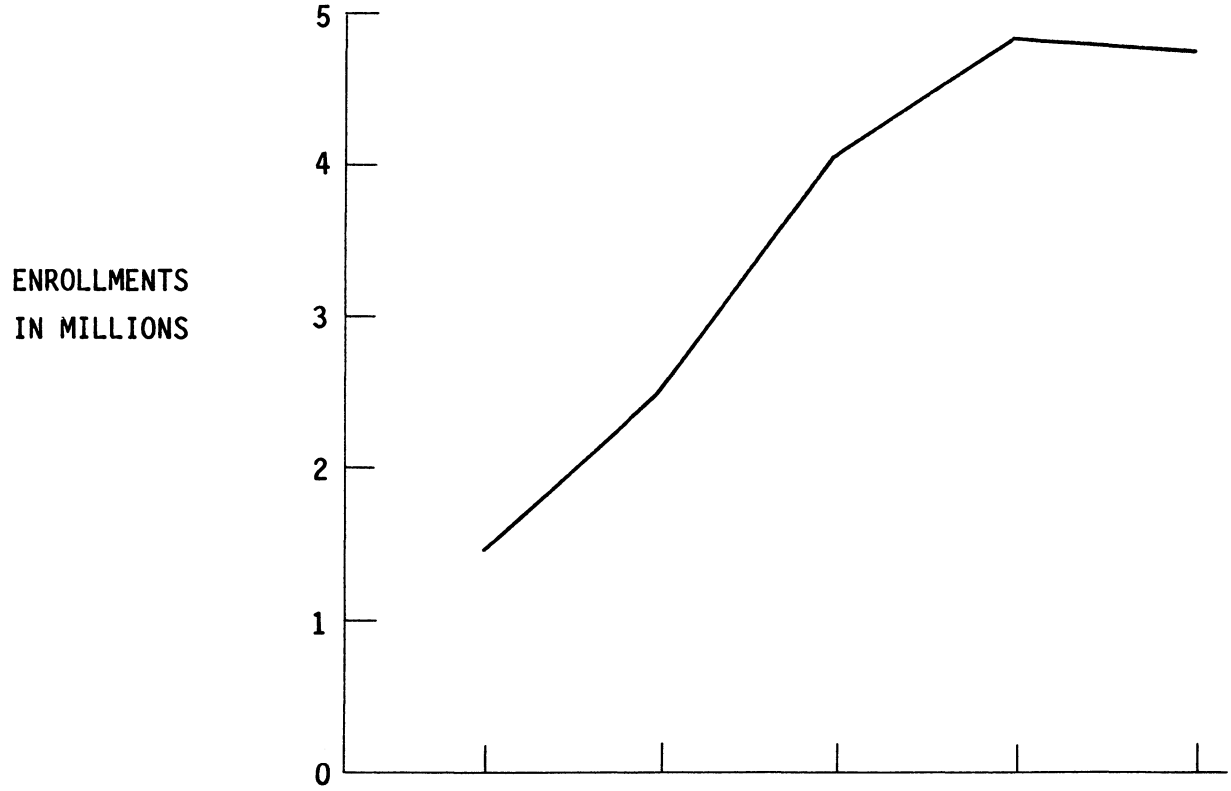
TRENDS IN OVERALL TWO-YEAR COLLEGE ENROLLMENTS, 1966-1985

Two-year college enrollments total about 5,000,000. They decreased by 2% over the period 1980-1985.

During that five-year period, mathematical science course enrollments showed virtually the same percentage decrease. This is the first decrease we have observed in our regular surveys. See Graph 5-C for mathematical science enrollments.

GRAPH 5 - A

TRENDS IN OVERALL TWO-YEAR COLLEGE ENROLLMENTS, 1966-1985



YEAR	1966	1970	1975	1980	1985
FALL ENROLLMENTS	1,464,099	2,499,837	4,069,279	4,825,931	4,730,235

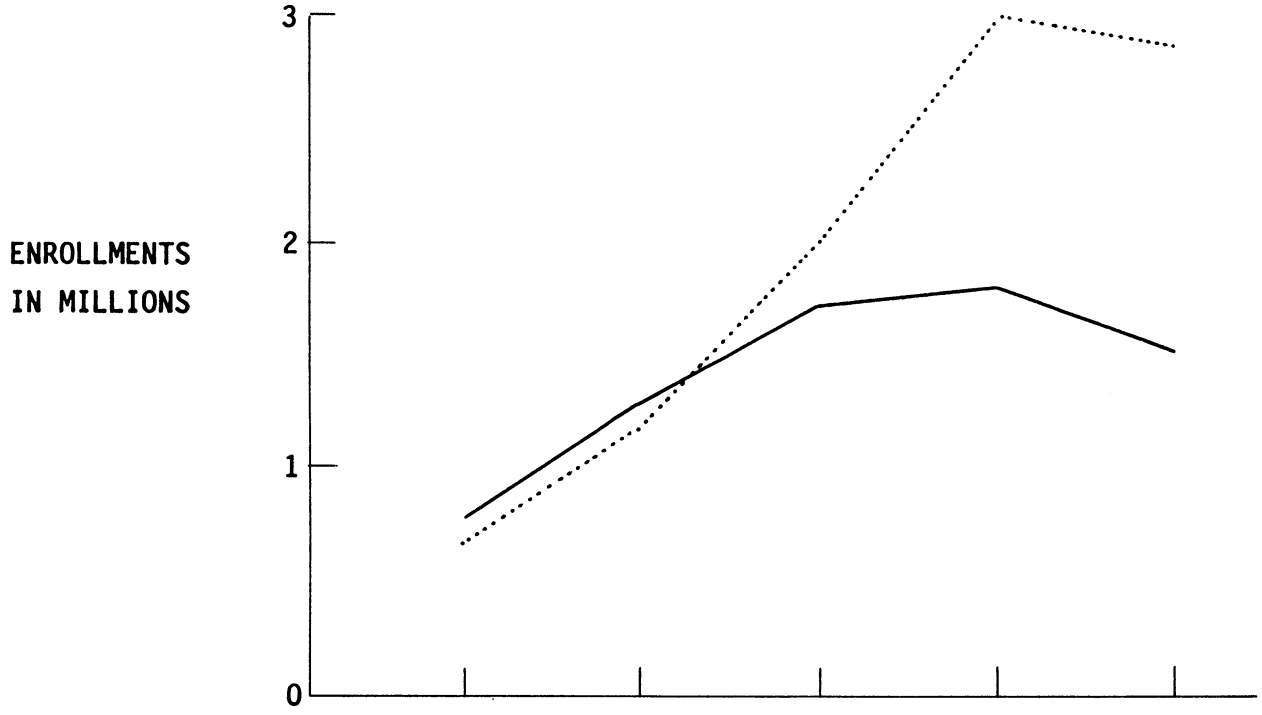
Source: 1986 Community, Junior, and Technical College Directory, AACJC, One Dupont Circle, N.W., Washington, D.C. 20036.

FULL-TIME VERSUS PART-TIME ENROLLMENTS IN TWO-YEAR COLLEGES, 1966-1985

Part-time enrollments overtook full-time enrollments in 1972. In 1985 part-time enrollments accounted for 65% of total enrollments.

GRAPH 5 - B

OVERALL FULL-TIME VERSUS PART-TIME ENROLLMENTS IN TWO-YEAR COLLEGES



YEAR	1966	1970	1975	1980	1985
FULL-TIME ENROLL.——	792,006	1,282,604	1,726,302	1,795,442	1,514,310
PART-TIME ENROLL.·····	664,157	1,164,797	2,002,269	2,996,264	2,873,466*

* The sum of full-time and part-time enrollments does not agree with total enrollments given on the previous page because the AACJC totals include "non-respondent" projections.

Source: Community, Junior, and Technical College Directories 1967, 1972, 1976, 1981, and 1986.

GROWTH OF ASSOCIATE DEGREES IN OCCUPATIONAL PROGRAMS IN TWO-YEAR COLLEGES, 1970-1985

Since 1973-74 associate degrees in occupational programs have outnumbered associate degrees in college transfer programs. According to Cohen*, students in occupational programs tend to graduate at approximately the same rate as students in other programs. However, some students who transfer to four-year colleges do not complete associate degrees before transferring.

TABLE 5 - 1

ASSOCIATE DEGREES IN TWO-YEAR COLLEGE PROGRAMS

	1970-71	1975-76	1980-81	1981-82
OCCUPATIONAL	42.6%	55.2%	62.6%	63.5%
COLLEGE TRANSFER	57.4%	44.8%	37.4%	36.5%

Source: Digest of Educational Statistics 1983-84, National Center for Educational Statistics, Washington, D.C., p. 137.

TRENDS IN TWO-YEAR COLLEGE MATHEMATICS ENROLLMENTS

A slight decrease in mathematics enrollments marked the period 1980-1985. This is the first decrease noted since CBMS began monitoring enrollments in 1966. The decrease was fueled by large percentage drops in business mathematics (down 42%), technical mathematics (down 53%), and mathematics for liberal arts (down 42%). Enrollments in mathematics for liberal arts are now one-half of the 1966 level.

Remedial courses continued to gain (up 9%) and now account for 47% of

*Arthur M. Cohen and Florence B. Brawer, The American Community College, Jossey Bass, San Francisco, 1982.

total enrollments. Calculus enrollments increased by 13% and statistics was up 29%. Computing course enrollments slowed dramatically, growing by only 3% in the period 1980-1985. Computing course enrollments are nearly equal to calculus enrollments.

In 1980 we observed: "Courses of an applied nature showed the largest percentage increase in enrollments over the period 1975-1980, reflecting the greatly increased occupational/technical focus of two-year colleges." Five years later, enrollments in applied courses slowed, with technical mathematics and business mathematics decreasing. The continuing decline in business mathematics, first noted in 1980, is puzzling. Business mathematics enrollments also decreased in divisions outside mathematics.

REMEDIAL COURSES

Since 1966, the growth of remedial courses has been large indeed. In fact, the remedial course group (arithmetic, general mathematics, elementary algebra, intermediate algebra, and high school geometry) now accounts for nearly one-half of all tyc mathematics enrollments. This growth has alarmed many individuals who are concerned about tyc mathematics.

In spite of the large overall enrollments, there is an indication that some improvement is occurring at the pre-algebra level (arithmetic and general mathematics): Over the period 1980-1985, pre-algebra enrollments decreased by 3%, the first decrease noted since 1966.

ENROLLMENT TRENDS IN MATHEMATICAL SCIENCE COURSE GROUPS 1966-1985

Overall enrollments in mathematics courses decreased by 1% from 1980-1985 and thus mirrored the overall enrollment decrease of 2% in two-year colleges.

GRAPH 5 - C

MATHEMATICS COURSE ENROLLMENTS OVER TIME

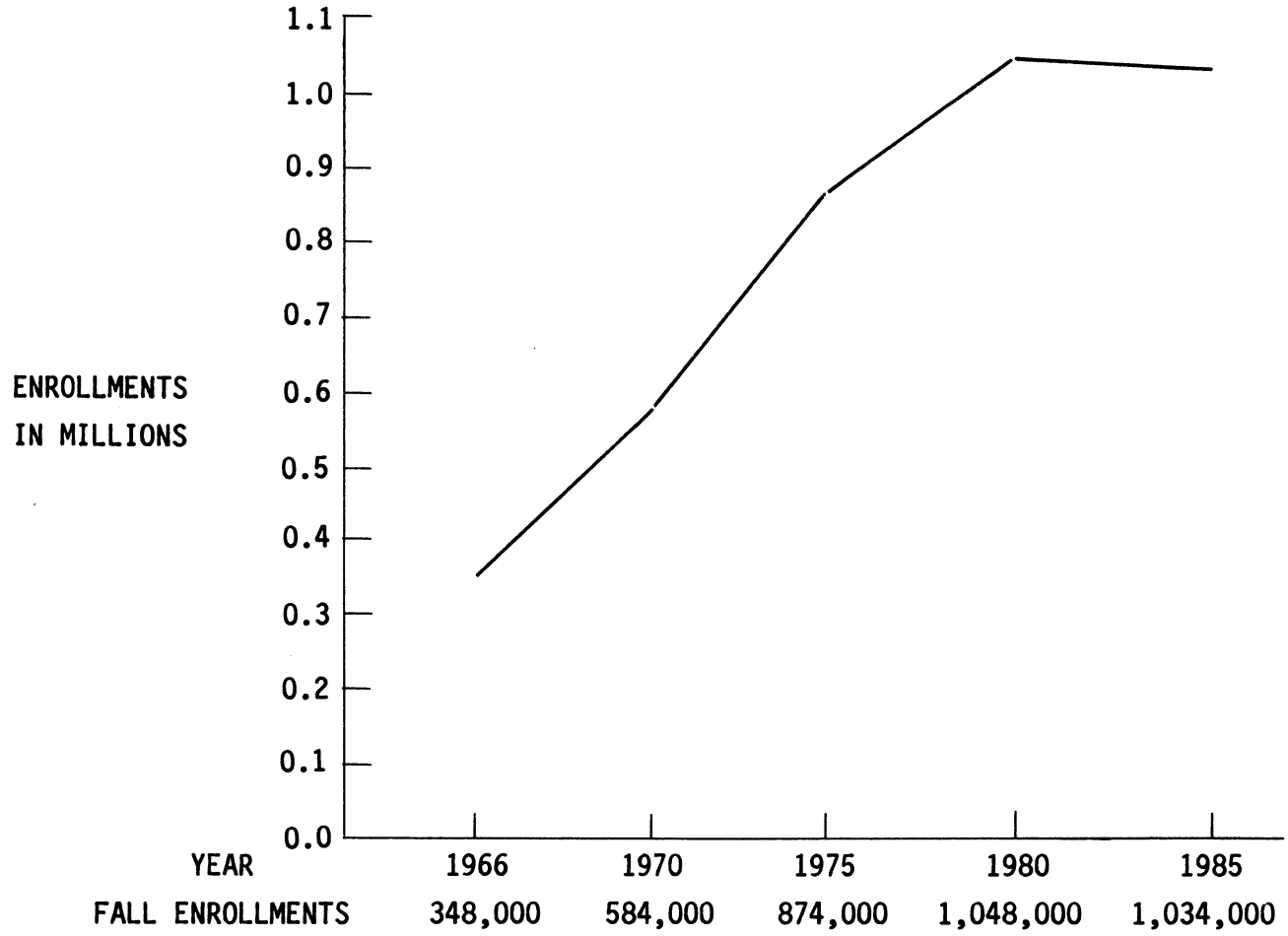


Table 5-2 gives enrollment trends by various courses and Graph 5-D, percentage trends in various course groups. Remedial course enrollments continued to grow over the 1980-1985 period, but their rate of growth decreased. Since 1980 the percentage shares of calculus, precalculus, and statistics have remained nearly level.

The computing boom of 1975-1980 seems to be over. Course enrollments in computing (including data processing enrollments) are only slightly higher than they were in 1980.

TABLE 5 - 2

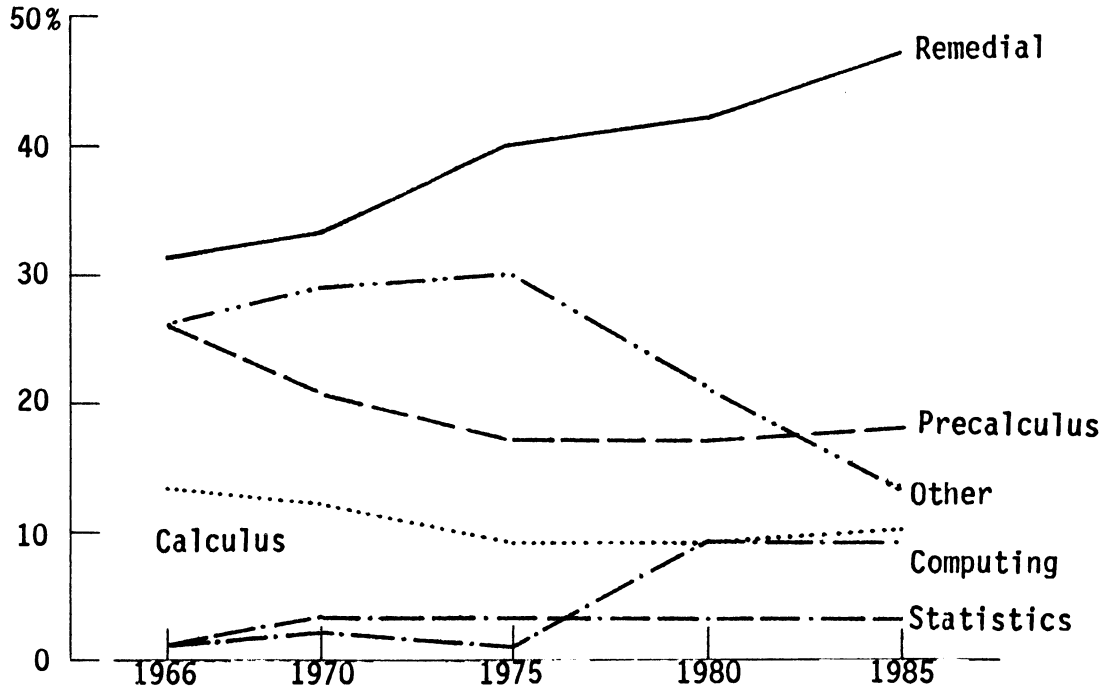
DETAILED FALL ENROLLMENTS IN MATHEMATICAL SCIENCES
IN TWO-YEAR COLLEGES, 1966-1985 (in thousands)

SUBJECT	1966	1970	1975	1980	1985
REMEDIAL					
1 Arithmetic	15	36	67	121	77
R General Mathematics	17	21	33	25	65
3 Elementary Algebra	35	65	132	161	181
4 Intermediate Algebra	37	60	105	122	151
5 High School Geometry	5	9	9	12	8
PRECALCULUS					
6 College Algebra	52	52	73	87	90
7 Trigonometry	18	25	30	33	33
8 College Alg. & Trig. (Combined)	15	36	30	41	46
9 Elementary Functions	7	11	16	14	13
CALCULUS					
10 Analytic Geometry	4	10	3	5	6
11 Analytic Geometry & Calculus	32	41	40	45	49
12 Calculus (math., physics & engr.)	8	17	22	28	31
13 Calculus (bio., soc., & mgt. sci.)	NA*	NA	8	9	13
14 Differential Equations	2	1	3	4	4
SERVICE COURSES					
15 Linear Algebra	1	1	2	1	3
16 Discrete Mathematics	NA	NA	NA	NA	L*
17 Finite Mathematics	3	12	12	19	21
18 Mathematics for Liberal Arts	22	57	72	19	11
19 Mathematics of Finance	4	5	9	4	1
20 Business Mathematics	17	28	70	57	33
21 Math. for Elem. School Teachers	16	25	12	8	9
22 Elementary Statistics	4	11	23	20	29
23 Probability & Statistics	1	5	4	8	7
24 Technical Mathematics	19	26	46	66	31
25 Technical Math. (calculus level)	1	3	7	14	4
26 Use of Hand Calculators	NA	NA	4	3	6
COMPUTING					
27 Data Processing (elem. or adv.)	NA	NA	NA	NA	36
28 Elem. Progr. (BASIC, COBOL, FORTRAN, Pascal)	3	10	6	58	37
29 Advanced Programming	NA	NA	NA	NA	5
30 Assembly Language Programming	NA	NA	NA	NA	4
31 Data Structures	NA	NA	NA	NA	2
32 Other Comp. Sci. Courses	2	3	4	37	14
33 Other Mathematics Courses	8	14	32	27	14
TOTALS	348	584	874	1048	1034

*(NA means "not available" and L means some but less than 500.)

GRAPH 5 - D

FALL ENROLLMENTS IN SELECTED TYPES OF MATHEMATICAL SCIENCE COURSES IN TWO-YEAR COLLEGES, BY LEVEL (As Percent of Total)



ENROLLMENTS IN THOUSANDS AND PERCENTAGES OF TOTAL

LEVEL	1966 NUMBER	1966 %	1970 NUMBER	1970 %	1975 NUMBER	1975 %	1980 NUMBER	1980 %	1985 NUMBER	1985 %	
Remedial* (Courses 1-5)	109	31%	191	33%	346	40%	441	42%	482	47%	———
Precalculus** (6-9)	92	26%	124	21%	149	17%	175	17%	182	18%	— — —
Calculus (10-14)	46	13%	69	12%	76	9%	91	9%	103	10%	·····
Computing & D.P. (27-32)	5	1%	13	2%	10	1%	95	9%	98	9%	—·—·—
Statistics (22-23)	5	1%	16	3%	27	3%	28	3%	36	3%	——·——
Other	91	26%	171	29%	266	30%	218	21%	133	13%	—··—
Total	348		584		874		1048		1034		

Note: This table was constructed using table on previous page. Percentages may not add to 100% due to rounding.

* Remedial courses include arithmetic, high school geometry, elementary algebra, intermediate algebra, and general mathematics (courses 1-5).

** Precalculus courses include college algebra, college algebra and trigonometry, trigonometry, and elementary functions (courses 6-9).

FIFTEEN YEAR TRENDS IN AVAILABILITY OF MATHEMATICS COURSES 1970-1985

Since 1970, remedial courses have become more widely available. In 1970, courses in arithmetic were taught in one-third of tyc's. In 1985, arithmetic was taught in more than one-half of tyc's. Calculus courses designed for engineering, science, mathematics, and physics are unchanged in availability since 1970. This steady availability may be explained in part by the introduction of new "soft" calculus courses designed for students in the biological, social, and managerial sciences. Soft calculus courses are available in 30% of tyc's.

Statistics is now taught in about three-fifths of tyc's; in 1970 it was taught in only two-fifths of tyc's.

The next table provides additional details on fifteen-year trends in availability. In contrast to the situation on availability of courses in four-year colleges where the questions asked were different in 1985 than in previous years (see the discussion preceding Table 1-7) the tyc questions for 1970 and 1985 seemed comparable. The results generally bear this judgment out. In the four-year college questionnaire, the issue was one of availability of upper division courses on a two-year cycle - an issue that hardly exists for two-year colleges where almost all courses would normally be taught every year.

TABLE 5 - 3

AVAILABILITY OF MATHEMATICAL SCIENCE COURSES IN TWO-YEAR COLLEGES
FIFTEEN-YEAR TRENDS, 1970-1985
Percentage of two-year colleges teaching the course

SUBJECT	FALL 1970	FALL 1985
REMEDIAL		
1 Arithmetic	37%	53%
2 General Mathematics	20%	41%
3 Elementary Algebra	48%	75%
4 Intermediate Algebra	56%	74%
5 High School Geometry	24%	18%
PRECALCULUS		
6 College Algebra	53%	76%
7 Trigonometry	64%	67%
8 College Alg. & Trig. (Combined)	41%	47%
9 Elementary Functions	25%	21%
CALCULUS		
10 Analytic Geometry	18%	17%
11 Analytic Geometry & Calculus	63%	58%
12 Calculus (math., physics & engr.)	41%	41%
13 Calculus (bio., soc., & mgt. sci.)	NA*	30%
14 Differential Equations	49%	40%
SERVICE COURSES		
15 Linear Algebra	17%	24%
16 Discrete Mathematics	NA	3%
17 Finite Mathematics	19%	27%
18 Mathematics for Liberal Arts	NA	25%
19 Mathematics of Finance	13%	5%
20 Business Mathematics	38%	34%
21 Math. for Elem. School Teachers	48%	31%
22 Elementary Statistics	41%	61%
23 Probability & Statistics	16%	15%
24 Technical Mathematics	41%	42%
25 Technical Math. (calculus level)	19%	18%
26 Use of Hand Calculators	NA	4%
COMPUTING		
27 Data Processing (elem. or adv.)	NA	28%
28 Elem. Progr. (BASIC, COBOL, FORTRAN, Pascal)	27%	46%
29 Advanced Programming	NA	19%
30 Assembly Language Programming	NA	12%
31 Data Structures	NA	5%
32 Other Comp. Sci. Courses	16%	16%

* (NA means not available - not gathered in 1970)

MATHEMATICS COURSES TAUGHT OUTSIDE OF MATHEMATICS PROGRAMS

We have previously noted the shift of two-year college enrollments to occupational programs. Many of these programs provide their own mathematics instruction. To get an approximation of the size of such "outside" offerings, we asked for estimates of enrollments in mathematics courses given by other divisions or departments. The estimates are probably not as reliable as other data presented in this report, because respondents did not have direct responsibility for these outside courses.

The majority of outside enrollments are found in computer science courses, data processing, and business mathematics. The divisions providing most of the outside courses are those which specialize in business and occupational programs.

In 1967, Jewett and Lindquist observed that "...The mathematics curriculum in junior colleges seems overwhelmingly designed for transfer students." Their words take on added importance in view of the continuing growth of occupational programs. Outside enrollments in mathematics and computer science, primarily in such programs, have nearly quadrupled since 1970 and are now estimated to be 35% of mathematics enrollments in mathematics programs. Without data processing, the estimate would be 20%.

Trends in "outside" enrollments had some parallels with "inside" enrollments: business mathematics and technical mathematics decreased and computing courses demonstrated little change from 1980. Other trends may be seen in Tables 5-4 and 5-5.

In 1985, computer science and data processing are the most prominent courses for "outside" mathematics enrollments. Computer science accounts for 27% of "outside" enrollments, decreasing slightly from 1980. "Outside" enrollments in business mathematics have decreased by 29% since 1980. "Inside" business mathematics enrollments also decreased, but by 42%. "Data processing" was not listed on previous surveys and may have been interpreted by some as "computer science and programming." If data processing is deleted, "outside" enrollments would have shown a decrease of 23%. However, some data processing may have been included in computer science totals prior to 1985.

TABLE 5 - 4

ESTIMATED ENROLLMENTS IN MATHEMATICS COURSES TAUGHT OUTSIDE OF MATHEMATICS PROGRAMS IN TYC'S, FALL 1985
(Enrollments in Thousands)

COURSES	1970	1975	1980	1985
Arithmetic	14	27	18	18
Business Mathematics	36	53	70	50
Calculus or Differential Eqns.	L*	4	8	L
Computer Science & Programming	21	51	92	97
Data Processing	NA*	NA	NA	159
Pre-Calculus Coll. Mathematics	6	17	29	3
Statistics and Probability	6	14	12	7
Technical Mathematics	NA	NA	25	23
Other	9	12	10	4
Total	92	178	264	361

* L denotes some but less than 500 and NA denotes not available.

DIVISIONS OTHER THAN MATHEMATICS THAT TAUGHT MATHEMATICS COURSES, FALL TERM 1985-1986

Business and occupational program faculties teach substantial numbers of mathematics courses.

TABLE 5 - 5

ENROLLMENTS IN COURSES IN OTHER DIVISIONS
(Enrollment in Thousands)

COURSES	NATURAL SCIENCES	OCCUPAT. PROGRAMS	BUSINESS	SOCIAL SCIENCES	OTHER	TOTAL
Arithmetic	L*	10	3	0	4	18**
Bus. Mathematics	0	4	46	0	L	50
Statistics & Prob.	0	0	4	2	L	7**
Pre-Calculus College Math.	0	3	0	0	0	3
Calculus or Diff. Eqns.	0	L	0	0	0	L
Comp. Sci. & Prog.	L	27	44	0	26	97
Data Processing	3	25	93	0	37	159**
Technical Math.	L	23	L	0	0	23
Other	0	4	0	0	0	4
Total	3	96	190	2	67	361**

* L denotes some but less than 500.

** denotes disagreement due to rounding.

COMPUTERS AND CALCULATORS IN TWO-YEAR COLLEGES

The percentage of two-year colleges reporting access to computers has increased from 57% in 1975 and now amounts to 84% of all tyc's. The mean number of computer terminals and microcomputers available for student use in mathematics courses is 19, with a median of 13. Department heads estimate that 59% of the full-time faculty know a computer language, the same percentage as in 1980. The number of faculty making use of computers in their teaching has doubled since 1975 and 32% of full-time faculty give some class assignments involving the use of the computer each year (in courses other than computer science). This figure is up from 21% in 1980. The impact of computers on mathematics teaching is growing but is still small; less than 7% of all sections of mathematics (excluding computer science) reported the use of computer assignments for students.

The impact of hand calculators on mathematics teaching is substantially larger than that of computers. Hand calculators are recommended for use in 43% of all course sections, up from 29% in 1980. Then, usage of calculators was concentrated in a small number of courses. Only courses in college algebra and trigonometry, trigonometry, statistics, and technical mathematics had usage rates in excess of 50%. (That is, the fraction of sections in which hand calculators was recommended exceeded 50%.) In 1985, 13 courses had usage rates over 50%: analytic geometry and calculus, business mathematics, calculus, college algebra and trigonometry, elementary functions, finite mathematics, mathematics for liberal arts, mathematics of finance, probability and statistics, soft calculus, statistics, technical mathematics (calculus level), and trigonometry.

INSTRUCTIONAL FORMATS FOR TWO-YEAR COLLEGE MATHEMATICS

The 1975 CBMS survey of two-year college mathematics noted the emergence of a variety of self-pacing instructional methods. The 1980 survey showed continued growth in use of self-pacing methods. The 1985 survey reveals a marked decrease in the use of self-pacing methods. The simplest explanation for this change is the decrease in teaching demands of faculty. From 1980-85

mathematical science enrollments decreased by 1% and the size of the faculty increased by 12%. Some would argue that the use of self-pacing methods increased, in part, during the 70's as a result of overloaded classrooms (and teachers).

For each of eleven instructional methods, the table below shows the percentage of two-year colleges reporting no use, use by some faculty, or use by most faculty of that instructional method in mathematics courses in 1985. The pronounced increase in the percentages of tyc's reporting no use of various alternative systems clearly shows the decline in popularity of all non-traditional instructional methods.

TABLE 5 - 6

INSTRUCTIONAL FORMATS

INSTRUCTIONAL METHOD	Not Being Used		Used By Some Faculty		Used By Most Faculty	
	1980	1985	1980	1985	1980	1985
Standard Lecture-Recit. Sys. (class size < or = to 40)	1%	1%	2%	14%	97%	85%
Large Lecture Classes (>40) with recitation sections	63%	77%	16%	19%	21%	4%
Large Lecture Classes (>40) with no recitation	76%	81%	12%	17%	12%	1%
Organized Program of Independent Study	37%	61%	62%	38%	1%	2%
Courses by Television (closed-circuit or broadcast)	73%	91%	27%	9%	0%	0%
Courses by Film	75%	96%	24%	4%	1%	0%
Courses by Programmed Instruc.	40%	69%	56%	27%	4%	4%
Courses by Computer-Assisted Instruction (CAI)	68%	74%	31%	24%	1%	2%
Modules	42%	68%	54%	25%	4%	6%
Audio-Tutorial	55%	75%	43%	24%	2%	2%
PSI (Personalized System of Instruction)	51%	76%	46%	20%	3%	4%

USE AND STAFFING OF MATHEMATICS LABORATORIES IN TWO-YEAR COLLEGES

Mathematics labs (math help centers, math tutorial centers) are relatively new adjuncts to mathematics instruction in two-year colleges. They may contain some or all of the following: tutors, calculators, computers, films, film strips, television units for playback of lectures or video cassettes, models, audio-tape units, learning modules, etc. Math labs have been established at a fairly constant rate since 1970 and can now be found in 82% of all two-year colleges, up from 68% in 1980. As shown in the table below, personnel of labs come from a variety of sources.

TABLE 5 - 7

SOURCES OF PERSONNEL FOR MATHEMATICS LABORATORIES

	Percent of TYC's Using Source
Students	48%
Full-time Members of Mathematics Staff	38%
Paraprofessionals	34%
Part-time Members of Mathematics Staff	30%
Members of Other Departments	19%
Other	3%

COORDINATION OF COLLEGE-TRANSFER PROGRAMS WITH FOUR-YEAR INSTITUTIONS

For two-year colleges with large degree-credit programs it is important to coordinate program offerings, advisement, and academic standards with the most likely four-year college or university destination of their students. Sixty-six percent of the responding tyc's reported that their mathematics offerings are subject to state regulation, and thirty-five percent reported official state-wide coordination of tyc mathematics offerings with those of

four-year institutions.

This may help to explain the low level of reported consultation of tyc mathematics departments with four-year college and university departments: less than once a year for thirty-five percent, yearly for forty-one percent, and more than once a year for twenty-three percent.